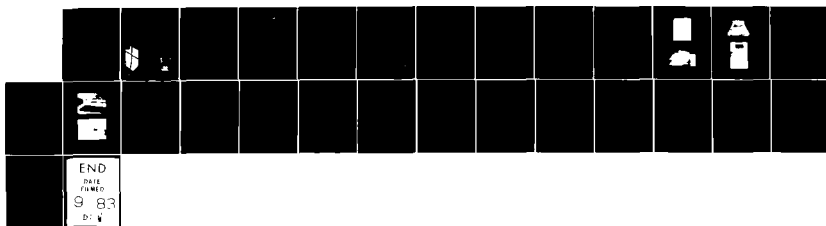


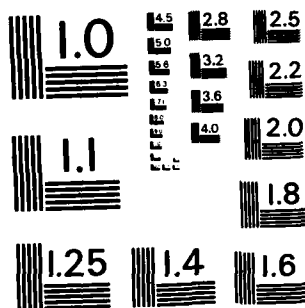
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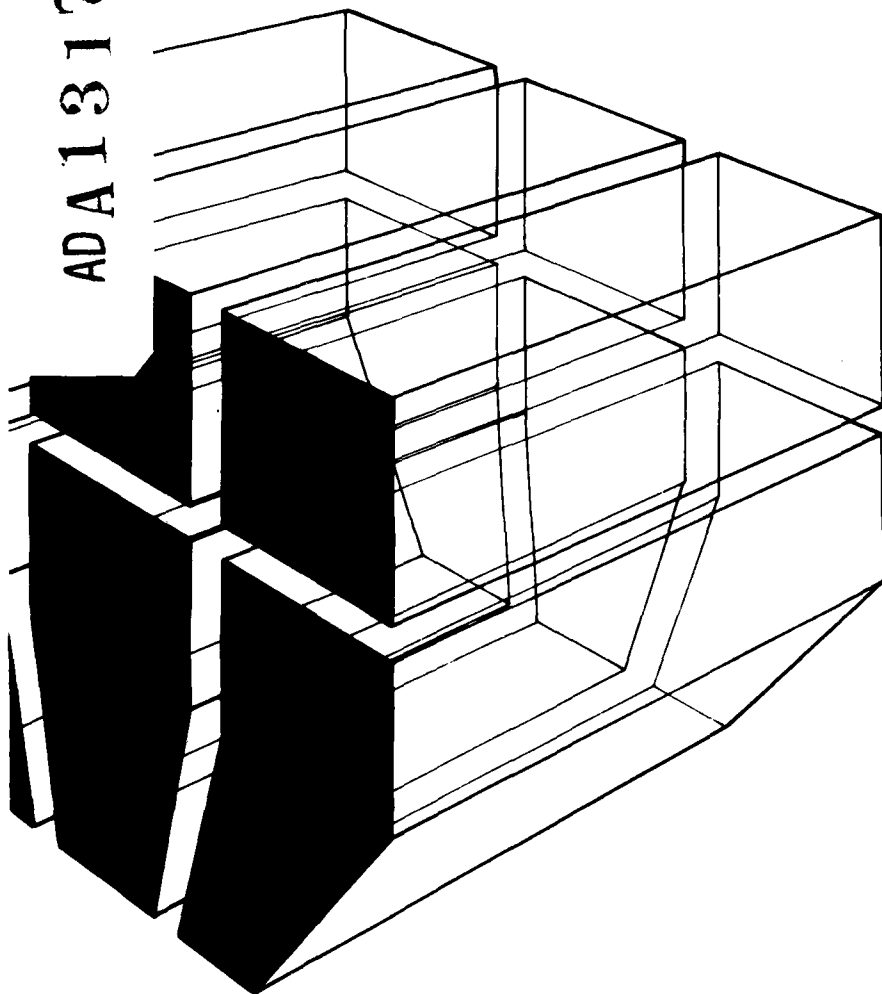
TECHNICAL REPORT N-159

June 1983

Solid Waste Management, Recycle, Resource  
Recovery for Military Facilities

PORTAWASHER: A SELF-CONTAINED DUMPSTER  
CLEANING SYSTEM

AD A131799



by  
G. Gerdes  
B. Donahue

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regulation mandates that dumpsters be maintained to "... (meet) general sanitary conditions and... prevent nuisances."

➤ To help installations fulfill the requirements of AR 420-47, the U.S. Army Construction Engineering Research Laboratory (CERL) has developed a portable self-contained washing apparatus called the Portawasher. This device cleans dumpsters onsite and retrieves the wash water for treatment and disposal. The Portawasher consists of relatively simple off-the-shelf equipment: a hot-water pressure washer and a vacuum wastewater retrieval system. This equipment, along with clean and wastewater tanks, is mounted on a tandem axle trailer and towed by a standard 3/4-ton pickup truck. The device can be operated by a single person. Capital, operating, maintenance, and labor costs for the Portawasher on a typical installation (Fort Leonard Wood, MO) are estimated to be \$11,050/year or \$5.50 per cleaning. Contracting the same workload using traditional cleaning methods would cost \$12.50 per cleaning at Fort Leonard Wood. The potential savings at Fort Leonard Wood by using a Portawasher is about \$14,000 per year. This report describes the development and field testing of the CERL-developed Portawasher and gives equipment specifications and operation and maintenance guidelines. ←

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## FOREWORD

This study was conducted for the Assistant Chief of Engineers under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities"; Task T2, "Pollution Abatement System"; Work Unit 007, "Solid Waste Management, Recycle, Resource Recovery for Military Facilities." Mr. R. Newsome, DAEN-ZCF-U, was the Technical Monitor.

The work was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL). Dr. R. K. Jain is Chief of EN. Acknowledgement is given to Banks Hudson, Jr., of BHI for his assistance during the initial dumpster washing research and to the engineers and technicians of Industrial and Municipal Engineering, Inc. (IME) for their valuable contributions to the final Porta-washer development.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.



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## PORTAWASHER: A SELF-CONTAINED DUMPSTER CLEANING SYSTEM

### 1 INTRODUCTION

#### Background

One aspect of Army-installation solid waste management is the maintenance of containers (dumpsters) used to store refuse before collection and disposal. Food wastes and other organic material often cling to the sides and bottoms of dumpsters, creating both a health hazard and an aesthetic nuisance by providing an excellent breeding ground for flies and roaches, a potential feeding area for vermin, and a source of unpleasant odors. Paragraph 2-4 of AR 420-47 states that refuse containers should be kept clean to retard the harborage, feeding, and breeding of vectors, and so that they do not constitute a nuisance.<sup>1</sup>

The Army now usually cleans dumpsters in two ways:

1. The dumpsters are transported to a central area for washing. The containers may be carried individually by a collection truck or on a flat-bed truck or trailer. At the washing area, the dumpsters are cleaned with high-pressure cold water, hot water, or steam.

2. The dumpsters are cleaned with a spray hose attached to a small pressurized water tank mounted on the collection vehicle. This method means the collection truck driver must do the cleaning. Military specifications require that all new front-loading collection trucks be equipped with spray hoses.<sup>2</sup>

Due to the high costs of the inefficient present methods of washing dumpster containers, the Army

must find a more economical way to conduct dumpster cleaning and maintenance. Carrying dumpsters individually to and from a central washing area wastes time, fuel, and manpower. Also, the vehicle-mounted tank and hand-held sprayer system does not clean dumpsters well enough to prevent potential environmental and health hazards. Thus, the Office of the Assistant Chief of Engineers, Facilities Engineering Division, Utilities Branch, asked the U.S. Army Construction Engineering Research Laboratory (CERL) to improve the efficiency of container cleaning operations by developing a device that could effectively and economically clean dumpsters onsite.

#### Objective

The objective of this research was to develop, test, and evaluate an effective, low-cost, onsite dumpster cleaning system for use at Army installations.

#### Approach

1. CERL conducted a state-of-the-art review of onsite dumpster cleaning methods. This review indicated a mobile cleaning unit had the most development potential.

2. CERL evaluated several equipment configurations for a mobile cleaning unit and selected a high-pressure, hot water washing system with vacuum retrieval of the wash water for further development.

3. CERL tested several prototypes while developing this system and determined optimal performance specifications.

4. A final prototype, trademarked the Corps of Engineers Portawasher, was built for demonstration and long-term evaluation.

#### Mode of Technology Transfer

Specification and Quick-Return-on-Investment Program (QRIP) data on the Portawasher are available in Engineer Technical Note (ETN) No. 81, *CERL Portawasher Technology* (Office of the Chief of Engineers, 14 April 1981). It is recommended that the information in that ETN and this report be used to update Army Technical Manual (TM) 5-634, *Refuse Collection and Disposal Repairs and Utilities* (Department of the Army, 1 July 1958) and Army Regulation (AR) 420-47, *Facilities Engineering Solid Waste Management* (Department of the Army, 9 June 1977).

<sup>1</sup> *Facilities Engineering Solid Waste Management*, Army Regulation (AR) 420-47 (Department of the Army, June 1977).

<sup>2</sup> Military Specification MIL-T-46701, "Truck, Tilt Frame, Container Handling, 51,000 Pounds, 6 x 4 Commercial, Including Detachable Bodies and Stationary Compactors," in *Military Specifications and Standards*, Vol 2 (May-June 1983), p. 1102; MIL-T-46748, "Truck, Refuse Collection, Compaction Type Body, with Front Container, Hoisting Device 6 x 4 Commercial," in *Military Specifications and Standards*, Vol 2 (May-June 1983), p. 1103.

## 2 DEVELOPMENT

### Portability

An assessment of the Army's usual dumpster cleaning methods indicated that carrying dumpsters to and from a central wash site was costly in terms of both labor and vehicle usage (i.e., gasoline and maintenance). It was apparent that an onsite cleaning method would greatly increase cleaning efficiency. This meant that cleaning equipment had to be identified or developed that could effectively clean dumpsters and could be used at any location.

A review of state-of-the-art cleaning systems identified four cleaning system types already in use at Government installations for sanitizing refuse dumpsters: a washout tank mounted on a collection truck (in use at many Army installations) and individually designed equipment used by the Norfolk Naval Station, VA, the Camp Pendleton Marine Base, CA, and the U.S. Forest Service in California.

### Truck-Mounted Washout Tank

Several collection truck manufacturers offer a washout tank option on their line of front-loading compactors. This option is required on all new Army container collection vehicles. The washout tank is a cylindrical, 100-gal\* tank mounted at the rear of most truck body models. The truck driver uses a hose and spray wand to spray the inside of the dumpsters after they have been emptied and before they are lowered and returned to their site. The tanks are usually pressurized to about 100 psi by the truck's air brake system.

While this system is simple and relatively inexpensive, it has two major disadvantages:

1. The pressure developed by the system is typically not high enough to clean most dumpsters. When the dumpster is in the hoisted position, it is difficult to get the spray wand close enough to adequately clean the dumpster.

2. Refuse collection vehicles are expensive to purchase and operate. They should be used to collect refuse efficiently, not for such labor-intensive operations as dumpster washing.

### Navy Washing System

The system most like the final Portawasher is that used at the Norfolk Naval Station. Norfolk actually has

two systems: one trailer-mounted and the other mounted on the bed of a stake body truck. The basic system consists of a propane-fueled hot water washer, a water tank, and a water pump to remove wash water from the dumpsters. Using this system, a two-person crew can clean 30 dumpsters per day. The 1970 cost to outfit a trailer with the system (Figure 1) was about \$3000.

### Camp Pendleton System

The Structure and Grounds Office at the Marine Base at Camp Pendleton has purchased a truck built exclusively to clean dumpsters (Figure 2). It has a front-loading compactor body modified by a now defunct California company. The front forks lift the dumpster onto the rear of the truck, where it is cleaned by the driver using a turret-mounted spray wand. A pump, run by a power take-off from the truck, supplies water to the wand at 1000 psi. As the dumpster is being washed, the dirty wash water falls into a reservoir built into the truck body. The water can be heated by a propane heating system in the reservoir, but this is seldom done. The wash water is recycled through filters and back to the wash wand. In 1972, the truck was purchased for \$36,330 and cost \$6.43 per mile to operate. Operating full time, the driver could clean 27 dumpsters per day.

### Forest Service System

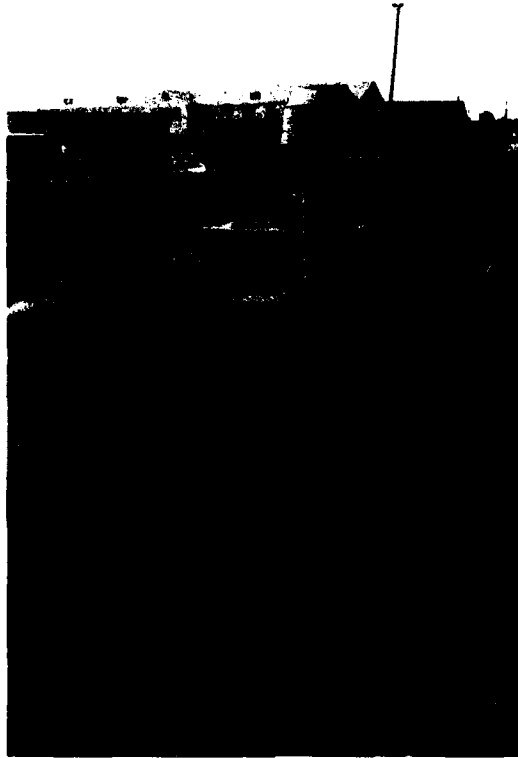
A mobile cleaning unit has been developed by the U.S. Forest Service Equipment Development Laboratory to clean restroom facilities in national parks. The unit consists of a 500-psi pressure washer, a portable wet/dry vacuum, a gasoline-driven alternator, and hose reels for the spray wand and extension cord. The equipment is mounted on a frame which can be placed into the bed of a pickup truck (Figure 3).

### CERL Prototype Tests

During CERL's investigation into the existing cleaning systems described above, advantages and disadvantages were noted so CERL could build a cleaning system prototype based on the lessons learned from these operations.

CERL's first prototype consisted of a 1000-psi pressure washer, a water pump, and a 100-gal water tank. The water pump removed the wash water from a dumpster and returned it to the water tank through a basket-shaped screen. All equipment was mounted on an aluminum frame designed to fit into the bed of a pickup truck (Figure 4).

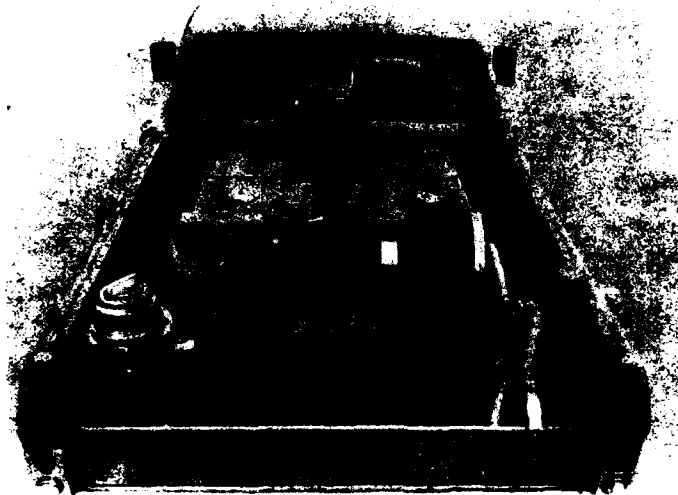
\*Metric conversion table is on p 22.



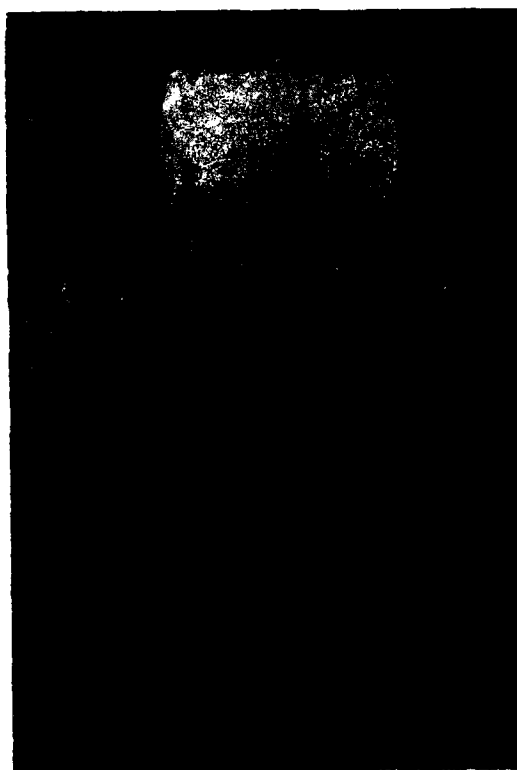
**Figure 1.** Norfolk Naval Station cleaning system.



**Figure 2.** Camp Pendleton cleaning system.



**Figure 3. Forest Service cleaning system.**



**Figure 4. CERL washing unit carried by ½-ton truck.**

When this first version was tested, the pump could not remove all of the water and solids from the bottom of the dumpster. It was replaced with a 100-cfm wet/dry vacuum mounted over a 55-gal drum (which replaced the 100-gal water storage tank). This second version was apparently effective and was taken to Fort Carson, CO, for field test. However, during the first day of testing, the water inlet to the pressure washer began clogging after only a short period of use.

It was during the field test that the decision was made not to attempt to recycle the wash water. It was obvious that screening alone would not recycle the wash water back to the pressure washer clean enough. A simple and cost-effective alternative was to have two reservoirs, one for clean water and one for collected wash water. A quick design change was made at the test site and the test was continued. The remainder of the dumpster washing evaluation at Fort Carson was successful, although the washing was somewhat more time-consuming than anticipated.

This version was then modified into the final truck-mounted prototype. Water capacity was increased to 100 gal for clean water and 100 gal for recovered water. This version was sent to Fort Lewis, WA, for an extensive evaluation period. Fort Lewis' evaluation was very favorable to both the equipment and the method. Their two major recommendations were to change the pressure washer to a hot water washer and to mount the equipment on a trailer.

#### **Final Prototype—Design Characteristics**

The design characteristics for the final Portawasher prototype are:

1. High-pressure washing. At least 1000 psi, but probably no more than 1500 psi, is needed to remove grime from the sides of the dumpsters.
2. Hot water. Hot water seems to wash best at 180 to 200°F. Hot water will remove oily dirt that is difficult to remove with cold water. Hot water also cleans better than steam because it has more impact pressure, makes it easier for the operator to see what he or she is cleaning, and uses safer, more economical operating temperatures.
3. Clean water storage of 200 gal. With practice, a dumpster can be cleaned with 10 gal of water. The operator should clean up to 20 dumpsters per day and should carry a full day's supply of cleaning water.
4. Waste water tank of 300 gal or larger. The capacity of the wastewater tank should exceed the clean water volume to allow for collected solids and other uses like spill cleanups, catch basin cleaning, and chemical toilet and vault latrine pumping.
5. A 30 cfm, 15-in. mercury vacuum pump. Water and solids are best removed by a vacuum sludge removal system, the type commonly used for servicing portable latrines.
6. Trailer-mounted. Mounting the equipment on a flat-bed truck would probably be most convenient, but trailer mounting is more economical and provides mobility without requiring a dedicated vehicle.
7. Self-contained unit. All power requirements must be provided by an internal combustion engine mounted on the trailer. Fuel for the hot water heater can be either gaseous or liquid and could be the same as the engine fuel.

#### **Costs Derived from Field Evaluation**

The economies of the final Portawasher prototype were evaluated during a field test at Fort Leonard Wood, MO. Tables 1 and 2 give the results of that test.

#### **Alternate Uses**

While the Portawasher was mainly designed and tested for cleaning refuse dumpsters, it has several other potential applications. The Portawasher is best suited for the onsite cleaning of containers, structures, and other essentially immovable property, particularly where the recovery of the wash water is important. While not suitable for cleaning tactical vehicles, the Portawasher can be used for cleaning administrative-type vehicles and equipment when permanent washing facilities are not available. The vacuum recovery system can be used to service portable latrines, for recovering liquid spills, for emptying tanks, or for any operation where liquid or sludge transfer is involved. During the evaluation period at Fort Leonard Wood, the Portawasher effectively cleaned up oil spills on pavement (Figures 5 and 6) and emptied sludge from an ash-quench tank under an incinerator.

#### **Procurement**

The specifications given in Chapter 3 can be used to purchase a Portawasher from a local manufacturer. Since the Portawasher can be assembled from off-the-shelf items, it qualifies for procurement through one of the Army's Productivity Capital Investment Programs

**Table 1**

**Portawasher Evaluation at Fort Leonard Wood, MO**

**Results for the Period 18 Dec 81 Through 22 Jul 82**

Number of dumpsters cleaned	1085
Labor (hours)	374*
Portawasher Onan engine (hours)	154**
Portawasher Onan engine (gal of regular fuel)	97
LPG for water heater (lb)	330
Truck fuel (gal)	324
Miles driven	2657
Water used (gal)	9645

**Performance**

Operation: 2.9 cleanings/hour\*  
 24.6 cleanings/day\*  
 8.5 minutes/cleaning at site

Fuel consumption:  
 Onan engine . . . . . 0.09 gal/cleaning; 0.67 gal/hr  
 3/4-ton truck . . . . . 8.2 mi/gal  
 LPG . . . . . 0.3 lb/cleaning

Water consumption: 9 gal/cleaning

\*Includes start-up, shut-down, maintenance, and rest and lunch breaks.

Assumes 8.5 hr/day.

\*\*Extrapolated from when the engine clock failed at 105 hours and 738 dumpsters cleaned.

**Table 2**

**Cost of Using Portawasher vs Cost of Contract Dumpster  
 Cleaning at Fort Leonard Wood, MO**

**Portawasher**

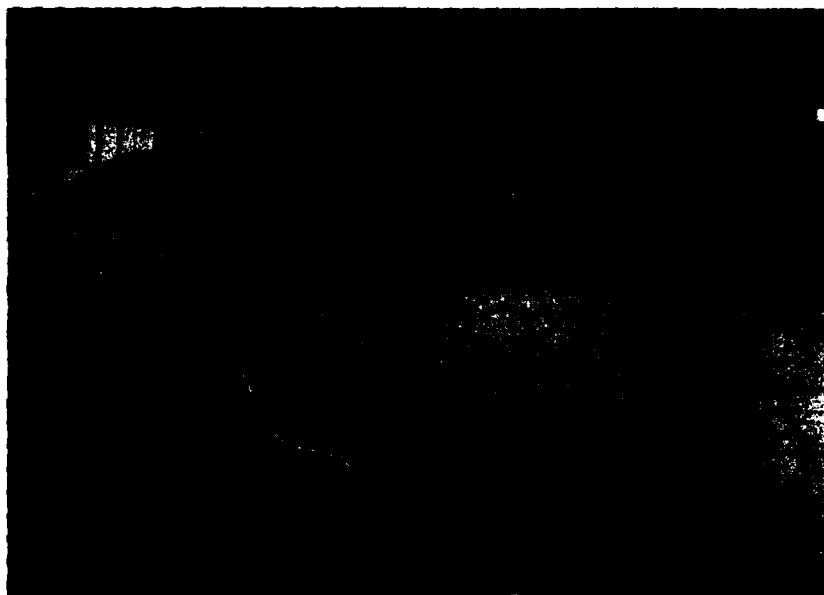
1. Capital cost \$20,000 (approx.) distributed over 5 years	\$4000/year
2. Operating costs \$3.26/cleaning x 2000 cleanings/year	\$6520/year
3. Maintenance and repair	\$ 528/year
Total Annual Cost	\$11,048/year

**Contracting**

Washing cost \$12.50/cleaning \$12.50/cleaning x 2000 cleanings/year	\$25,000/year
Total Annual Cost	\$25,000/year



**Figure 5. Using the Portawasher to remove spilled oil.**



**Figure 6. Washing pavement to complete Portawasher spill cleanup.**



(PCIPs). If it were to be procured with Other Procurement Army (OPA) funds, an installation could use the Quick Return on Investment Program (QRIP).\*

### 3 SPECIFICATIONS

The Portawasher can deliver up to 1200 psi at a flow as low as 4 gpm. The heater element can provide at least 190°F water at the maximum water pump flow rate. Its tank holds 400 gal of clean water and 600 gal of vacuumed waste water and solids.

The Portawasher is a self-contained cleaning system that consists of:

Pressure washer

Vacuum pump

Water heater

Engine

1000-gal, divided tank

Tandem axle trailer

Hoses, belts, valves, and accessories.

#### Trailer

All Portawasher components and equipment are mounted on a trailer towed by a 1-ton truck. This trailer must meet the following requirements and have the following components:

1. Be a tandem axle capable of safely supporting a minimum gross weight of 12,900 lb.
2. Have a shock-absorbing suspension to protect the mounted equipment.
3. Have an independent braking system actuated by slowing the towing vehicle, a brake light system, and wheel shocks.

\*A detailed example of a QRIP request is given in ETN No. 81, *CERL Portawasher Technology*. The same information given in the ETN can be used to procure the Portawasher under the Army Industrial Fast Payback Program or one of the Army's other PCIPs.

4. Have a tongue with safety chains, an emergency brake, and a lunette eye.

5. Have three mounted leveling jacks: one at each corner and one on the tongue.

6. Have catwalks with climbing steps placed along each side of the tank to allow safe and easy access to the ports, hoses, and gages on top of the tank.

7. Have built-in trailer hooks or other means of securing the vacuum hoses during transportation of the Portawasher.

8. Comply with all Department of Transportation requirements for over-the-road vehicles.

#### Tank

1. A single-unit tank with a 1000-gal nominal capacity ( $\pm 2$  percent) must be mounted on the trailer. The tank's forward compartment must have 40 to 45 percent of the total capacity used for the clean water supply. The rear compartment (55 to 60 percent of the total capacity) is used for the vacuum collection of wastewater and semiliquid wastes.

2. The wastewater (rear) compartment, as delivered, must be able to maintain 15-psig pressure with a minimum loss due to leakage of 2 psi/30 minutes and maintain a 20-in. vacuum with a minimum gain due to leakage of 2 psi/30 minutes.

3. The interior of both compartments must be coated with a coal-tar epoxy meeting Corps of Engineers Specification C200.

4. The clean water (forward) compartment must have the following fittings and attachments:

- a. A top-fill hole, 6 in. in diameter, with a 6-in. PT\* fitting, cap, and vent.
- b. A 2-in. drain hole in the bottom center fitted with a 2-in. "T" and positioned to completely drain the compartment. One end of the "T" must fit the water inlet hose to the pressure washer. The other end of the "T" must be fit with a 2-in. ball or gate valve and a 2-in. male PT fitting and cap.

\*PT refers to cam-lever hose couplings or fittings the same as or equivalent to those manufactured by PT Coupling Co., Enid, OK.

c. A 2-in. female PT (a male garden hose adapter must be provided).

d. A sight glass of transparent material installed along the full height of the tank (as practical) so the water level at any depth can be observed.

5. The wastewater (rear) vacuum compartment must have the following fittings and attachments:

a. A 3-in. inlet port at the top toward the rear with a male PT fitting and cap.

b. A 3-in. female PT and a 2-in. male PT adapter.

c. A port to attach the hose from the vacuum pump.

d. A dual pressure/vacuum gage with a range of 30 psig pressure to 30 in. Hg vacuum mounted at the top.

e. A clean-out manhole and door located at the rear of the tank and positioned so wastewater and semi-liquid waste will drain out of the hole. It must be at least 20 in. in diameter and have a hinged door, be secured by hand-tightened wing nuts, and sealed watertight by a Buna-N Duro-70 gasket or equivalent.

f. A 1-1/2-in. port and ball valve installed on top of the tank to release the pressure or vacuum inside the tank.

g. A ball-float type, mechanical level indicator to show the waste level. The liquid level must be displayed on a dial or similar means on the side of the tank and constructed so there will be no leakage to the tank's exterior. The float ball must be stainless steel.

h. A 4-in. discharge port with a gate valve and a male PT fitting and cap positioned in the rear door (or equally accessible place) for maximum drainage.

i. A 4-in. diameter, 15-ft long hose for draining the tank, with a female PT fitting to attach to the discharge port.

j. Three 10-ft lengths of 2-in. ID, noncollapsible, flexible, smooth-walled vacuum hose. Two of the hoses must each be fit with male and female PT fittings. The third hose must have only one female PT fitting.

k. A 2-in. OD, double-curved metal vacuum wand between 3-1/2 and 5 ft long, the same as or equivalent to the Clarke wand, Part No. 719801-3, manufactured by the Clarke-Gravely Corp., Muskegon, MI.

l. An 8- to 12-in.-wide vacuum tool to fit on the end of the vacuum wand, the same as or equivalent to the Clarke 12-in., wide-mouth gulper tool, Part No. 718805-5.

m. A 3- to 4-ft section of flexible vacuum hose, 2-in. ID, to allow the vacuum wand to move freely.

#### Pressure Washer

A pressure washer pump, appropriate plumbing, and spraying apparatus must be mounted on the trailer. The pump is coupled to the engine via at least two belts and has an electric clutch for disengaging the pressure washer from the power train. The following conditions must be met, and the following fittings and attachments must be provided.

1. The pump must have a minimum output rating of 1200 psi, at a flow of between 4 and 5-1/2 gal/minute, using a triplex pump the same as or equivalent to a Cat pump model no. 00333. An inline, easily removable strainer must be provided to protect the pump.

2. Water must gravity feed to the pump inlet from a port in the bottom of the clean water compartment through flexible 1-in. ID hose capable of providing 150 percent of the maximum output flow of the pump.

3. All hoses, connectors, and pipings from the pump exit to the spray nozzle must be designed to safely withstand 1500 psi. The plumbing between pump and water heater must be 3/4 in.

4. Plumbing must be designed so that water flows from the pressure pump to the water heater to the spray hose.

5. The pressure pump must be protected during idling periods to prevent it from damaging itself. It must also have a pressure relief valve at the outlet to vent water back into the system. A temperature relief valve must also be incorporated to protect the pump.

6. A washing wand with trigger-hand grip, the same as or equivalent to Gunjet No. 20, manufactured by Spraying Systems Co., must be provided. This will

allow the operator to turn the flow on or off and adjust the pressure from 0 to maximum. The wand must be 3 ft long and have a 3-ft extension and an insulated, sliding handgrip. Four spray nozzles must be provided that have quick disconnects that attach to the end of the wand: 0°, 15°, 25°, 40° (the same as or equivalent to Spray System Co. Part Nos. 0010, 1510, 2510, 4010). There must also be a four-position turret nozzle which has a 0° and three other different spray patterns.

7. Fifty feet ( $\pm$  10 percent) of 1/2-in. ID flexible high-pressure hose capable of withstanding at least 1500 psi at 210°F to the wash wand.

8. A spring-loaded hose storage reel mounted on the trailer to store and dispense the washing wand hose. The reel should not require that any hoses be disconnected.

9. A mechanism, clamp, or other means of securing the spray wand for travel mounted near the hose reel.

10. A device installed behind the water heater for feeding soaps, detergents, and chemicals into the high-pressure wash water. This device must have a calibrated means of measuring the chemical flow into the water stream.

#### **Water Heater**

A water heater must be mounted on the trailer to heat the wash water after it leaves the pressure pump. The following requirements must be met and the following attachments or equipment provided:

1. The heater must provide high-temperature water through the use of a directed flame through coiled tubing. The burner fuel must be fuel oil or diesel fuel.

2. The heater must continuously provide at least 190°F water at the maximum flow of the pressure pump.

3. The burner must automatically shut down when there is no water flow through the coils.

4. The burner must have an independent on/off switch, automatic ignition, and a thermostat that will control the exiting water temperature to allow a minimum range of at least 100 to 200°F.

5. The heater flame exhaust must exit vertically from a point at least 6 ft above ground level. The heat

exchanger must be insulated and jacketed to protect the operator.

6. Any needed electrical power must be provided by an appropriately sized alternator mounted on the trailer and driven by the engine powering the washer and vacuum pump.

7. Fuel storage must be provided for at least 3 hours of continuous operation or a minimum capacity of 9 gal, whichever is greater.

#### **Vacuum Pump**

A vacuum pump must be mounted on the trailer to develop the vacuum or pressure in the wastewater (rear) compartment. The vacuum system must satisfy the following minimum requirements:

1. The inlet and outlet of the pump should be designed with appropriate valving so the vacuum hose to the wastewater (rear) compartment can either pressurize or evacuate, depending on whether the suction or exhaust ports of the pump are used.

2. The vacuum pump must be able to maintain a continuous static vacuum of 15-in. of Hg, a minimum continuous flow of 30 cfm, and a static pressure in the wastewater compartment of 15 psig.

3. The pump must be air cooled and have a totally automatic, self-contained lubrication system.

4. There must be a trap with a ball-float mechanism in the connecting system from the tank to the pump to prevent any liquid or solids from entering the pump.

#### **Power Supply**

1. All components requiring power (i.e., the vacuum pump, pressure washer pump, and alternator, if required for the water heater), must be belt-driven and powered by a gasoline or diesel-fired internal combustion engine.

2. The engine must have at least two cylinders, with a minimum power rating of either 120 percent of the sum of the power requirement of the components being driven, or 24 hp, whichever is greater.

3. The engine must be electrically started by a key ignition and a 12-V, heavy-duty battery.

4. The engine must be able to recharge the battery.

5. Fuel for the engine must be stored in an 11-gal or larger vented tank and pumped to the engine via a fuel pump. The fuel line to the engine must have a fuel filter and a shut-off valve.

6. The engine must be mounted on the trailer to allow for the easy access and use of the oil drain, oil fill and dipstick holes, and oil and air filters.

7. An electric clutch must be mounted in the power train to independently disengage the pressure washer pump (and alternator, if required for the heater) while the engine is running.

8. Exhaust from engine must be released according to the Occupational Health and Safety Administration (OSHA) standards through a rigidly supported exhaust system and insulated to prevent burns from accidental contact. Rain caps and spark arrestors must be installed at the end of the exhaust system.

9. All OSHA requirements must be met for operator safety and comfort during operation.

#### **Exterior Paint**

1. The tank and trailer must be painted flightline yellow, or equivalent.

2. Other components mounted on the trailer, except hoses and fire extinguisher, must be painted medium blue.

3. Painting must consist of two primer coats and two enamel finish coats.

4. Paint must be DuPont Deluxe, or equivalent.

#### **General**

The tank and equipment must be positioned on the trailer so that the tongue weight does not exceed 600 lb, empty or loaded. Under no conditions can the tongue weight be less than 100 lb.

A 10-lb multipurpose dry chemical fire extinguisher must be mounted on the trailer so that it is easily

accessible and away from the heater and fuel storage (minimum rating must be 4A60 BC).

The electrical system must be wired so the power switches, clutch engaging switches, thermostat, and ignition switch are mounted on an easily accessible panel and plainly labeled.

The noise level of the Portawasher in full operation must conform to OSHA standards (Section 1910.95) on occupational noise exposure.

The Portawasher must comply with all applicable Department of Transportation, OSHA, State, and other Federal regulations to ensure safe operation and to allow travel on all local, State, and interstate highways, bridges, and tunnels.

#### **Reliability**

All components of the Portawasher must have a design life of 10 years, except for wear parts that would be replaced during scheduled maintenance. The design life must consider the use schedule of the Portawasher as being at least 15 cleanings per day, requiring starting and stopping the engine, for 225 days/year.

The Portawasher, as delivered, must have the appropriate weight distribution and suspension to allow for smooth towing by a 1-ton truck.

The Portawasher must be built so all ports, caps, valves, hoses, switches, belts, gauges, fill holes, drain holes, fillers, spark plugs, fuel tanks, points of lubrication, and all parts which involve operation or maintenance are positioned so they are easily used or serviced.

The engine, pressure pump, water heater, and vacuum pump assembly must be mounted on a shock-absorbing system to prevent damage during travel.

Figures 7 and 8 show top and side views, respectively, of the Portawasher.

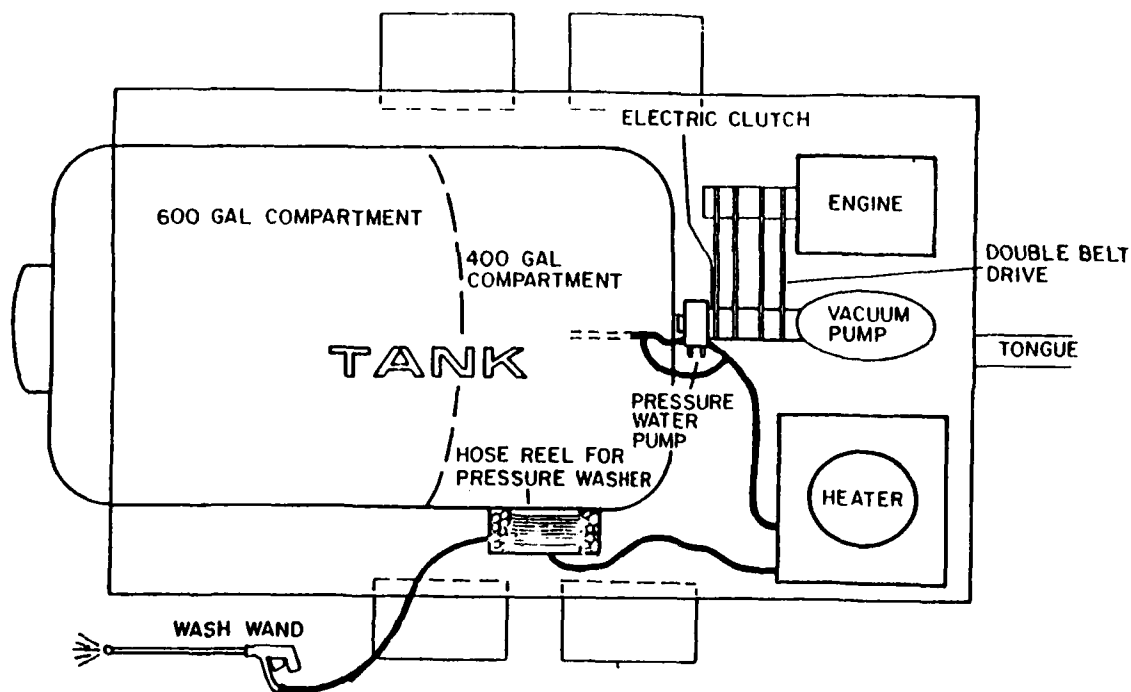


Figure 7. Portawasher—top view.

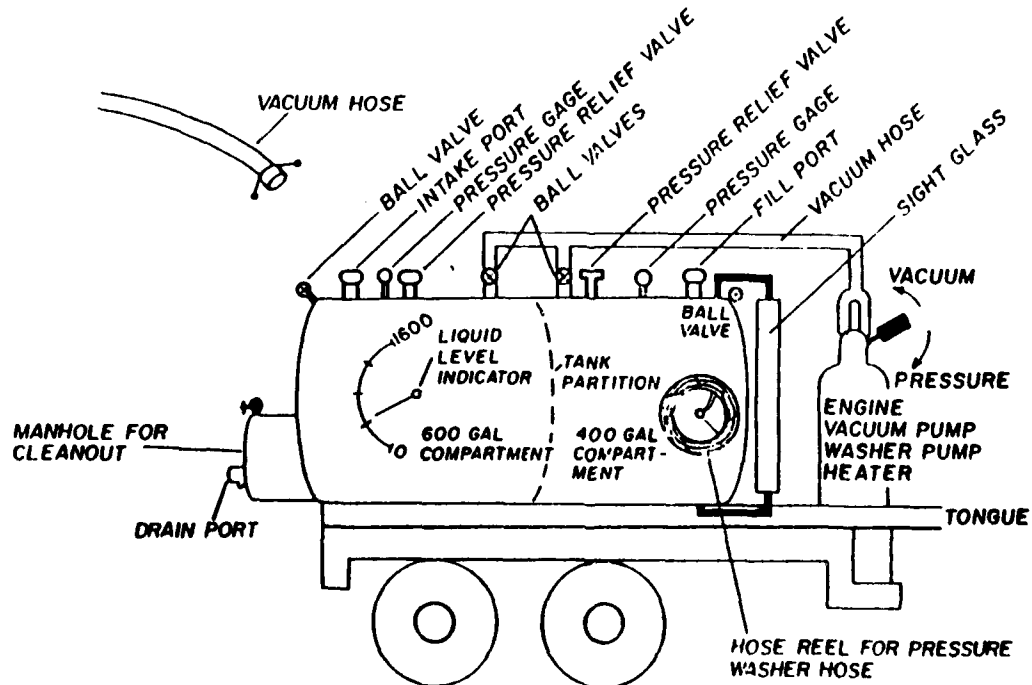


Figure 8. Portawasher—side view.

## 4 MAINTENANCE

### General

#### *Quality and Frequency of Cleaning*

Refuse containers are not considered adequately cleaned until all food particles have been removed, since food particles produce unpleasant odors and are good habitat for insect eggs and larvae, which are possible disease vectors.<sup>3</sup> (Adult flies emerge from garbage 2 or 3 days after it is placed in the container; fly eggs may develop into breeding adults in as little as 4 days.) But only containers which receive food and other putrescible wastes need frequent cleaning. Containers which receive mostly paper wastes can be cleaned less often, if at all, since paper is abrasive and acts as a cleaning agent, does not easily rot, and is not good habitat for disease vectors.

For good fly control, the ideal cleaning schedule is twice a week for food waste dumpsters (like those found at mess halls) and perhaps once a month for paper-waste dumpsters. However, this schedule is not realistic for most installations. A less effective, but more practical cleaning schedule is once a month for food waste dumpsters and twice annually for the remaining dumpsters.

#### *Detergents and Disinfectants*

Many installations add detergent or disinfectant to their cleaning water. Although this increases the degree of sanitation, it also increases the cost. However, detergents do enhance the cleaning ability of high-pressure hot water: most common detergents have a sodium phosphate base, but the stronger potassium phosphate-based detergents are recommended for dumpster cleaning.

Disinfection may not be absolutely necessary for dumpster cleaning, although it is desirable. If an installation does use a germicide, Directorate of Engineering and Housing (DEH) personnel should choose the product carefully and may wish to consult with their preventive medicine officer. The chosen disinfectant should have a long period of activity and should

be soluble in water (many phenols and chlorinated phenols are not soluble in water). The following should also be considered:

1. Ammonia compounds are easily activated by grime and dirt.
2. Iodine compounds, while able to kill quickly, can be corrosive.
3. Many products cannot be used near food or food equipment.
4. The effectiveness of some chemicals is determined by the pH of the cleaning water.

#### *Dumpster Washing Procedure*

Like any other piece of labor-saving equipment, the Portawasher cannot be effective unless it is used properly. Thus, a smooth routine for the cleaning operation must be set up. The Portawasher operator must coordinate the washing schedule with the collection truck driver's route to ensure that the dumpsters scheduled for washing have been emptied. Table 3 gives a suggested cleaning routine and lists accessories useful to the cleaning operation.

#### *Scheduled Maintenance*

The Portawasher's scheduled maintenance depends on the type of components that have been built on a given Portawasher. Since the Portawasher design specifications (Chapter 3) do not require that a particular component manufacturer be used, an installation purchasing a Portawasher must obtain all service manuals for their particular machine as part of the procurement contract. Table 4 is an example maintenance schedule for the components on the CERL Portawasher prototype.

#### *Cold Weather Storage*

The Portawasher can be seriously damaged by cold weather. To protect the pressure washer pump, the heater coils, and all water lines, a mixture of antifreeze and water (the same ratio that is put into vehicle engines) should be flushed through the system before the Portawasher is stored for the winter. It is not recommended that the Portawasher be used in sub-freezing weather.

<sup>3</sup>Refuse Collection and Disposal Repairs and Utilities, Army Technical Manual (TM) 5-634 (Department of the Army, 2 July 1958).

**Table 3**  
**Suggested Cleaning Routine and Cleaning Accessories**

**Accessories**

- Straight-edged shovel
- Scraper
- Trash can or trash bags
- Detergent and/or disinfectant
- Goggles and breathing mask
- Drain plug for blocking dumpster drain holes
- Rags
- Rubber gloves for mixing detergents or disinfectants

**Daily Operation--Start Up**

1. Fill water tank.
2. Fill fuel tank(s).

**Daily Operation--Cleaning Routine**

1. Scrape the dumpster's inner surfaces when there is an excessive buildup of materials, and shovel scrapings into the trash can.
2. Place the wastewater retrieval vacuum hose in the lowest corner of the dumpster. Raise one corner of the dumpster to help the wash water drain toward the vacuum hose.
3. Put a plug in the dumpster's drain hole.
4. Select a nozzle tip and attach the tip and spray wand to the pressure-washer trigger grip.
5. Light the heater pilot (on gas-fired models).
6. Set the vacuum pump valve to "vacuum."
7. Start the engine, set the thermostat, turn on the heater, and turn on the pressure washer.
8. Open the chemical feed valve (if adding chemicals).
9. Wash the dumpster. Wash the bottom first, then the sides and top. Hold the nozzle tips close to the dumpster surface.
10. Turn off the chemical feed and rinse the dumpster. Rinse from top to bottom, washing wastes toward the vacuum hose.
11. Vacuum any residual water and sediment from the dumpster's bottom. Use appropriate vacuum attachments.
12. Turn off equipment, switches, valves, etc. Pack up all equipment and move to the next dumpster.

**Daily Operation--Shut Down**

1. Drain the wash water to a sanitary sewer and rinse out the inside of the wastewater tank.
2. Release the pressure on the wash hose by pulling the trigger. Aim the trigger safely at the ground.

**Table 4**  
**Maintenance Schedule for CERL Portawasher Prototype**

**Components requiring maintenance**

1. IME vacuum pump
2. Onan engine
3. Cat pump
4. IME trailer
5. Hydro Systems water heater.

**Daily (after 5 hr operation)**

1. Check vacuum pump oil. Add 20W nondetergent oil, as needed. (The pump consumes about 1 qt every 4 hr.)
2. Check Onan engine oil. Add 30W SE or SE/CC detergent oil, as needed.
3. Check the secondary moisture trap (mounted above vacuum pump) for water or foreign material. Clean as necessary. If the secondary moisture trap requires servicing, also check the primary moisture trap (mounted inside the wastewater tank).
4. Under severe dust conditions, check the air cleaner on the Onan engine. Service as needed. (See Onan manual No. 4-409-002.)

**Weekly (after 30 hr of operation)**

1. Clean and lubricate the shaft of the 6-in. rear unloading valve (mounted on the manhole door) with lightweight machine oil.
2. Grease all the unit's zerk fittings (VAL LITH No. 2ep PT No. 609)
  - a. Drive end of the vacuum pump.
  - b. Spring shackles (located between the leaf springs of the front and rear wheels).
3. Check for and tighten loose bolts and wheel lug nuts.
4. Check the brake fluid level in the master cylinder (located in tongue). Add type DOT 3 Heavy Duty brake fluids, as required. If fluid is needed, check all lines and fittings for breakage. The master cylinder cap is located to the rear of the emergency brake lever.)
5. Wash out the vacuum pump with diesel fuel.
  - a. Remove the breather air line (a 2-in. hose located on the vacuum pump near the pressure-vacuum lever).
  - b. Put the vacuum pump on the pressure setting.
  - c. Open the pressure relief valve at the rear of the tank.
  - d. Start the engine and operate it at a moderate speed.
  - e. Pour 2 gal of diesel fuel slowly into breather opening.
  - f. Allow time for the diesel to clean the pump and pass through the system, then shut the engine down.
  - g. Drain the secondary moisture trap, replace the plug, and shut the rear valve. Do this outdoors, away from sparks or flame.



**Table 4 (Continued)**  
**Maintenance Schedule for CERL Portawasher Prototype**

6. Tighten hose clamps, as necessary.
7. Check valves for leakage. Repair any leaks.
8. Make sure all the cam-loc fittings on hoses and caps have gaskets in place and that all fittings are functional.
9. Check the battery fluid level. Add clean or distilled water, as necessary.
10. Check and clean the air cleaner element on the Onan engine by gently tapping it on a flat surface.

**Biweekly** (after 60 hr of operation)

Make sure the pump's drive belts are tight. There should be no slippage when pumping at 15 psi. When tightening, always move both tightening bolts equally.

**Monthly** (after 100 hr of operation)

1. Check the breaker points on the Onan engine ignition. Replace them, if necessary.
2. Replace the spark plugs (Onan No. 167-0240 or equivalent). Set the plug gaps at 0.025 in. (0.64 mm).

**Bimonthly** (after 200 hr of operation)

1. Change the oil and filter on the Onan engine.
2. Change the air cleaner element.

**Every 6 Months**

1. Change the oil in the Cat pressure washer pump. Use the special oil available from the Hydro System dealer.
2. Repack the wheel bearing.

## 5 CONCLUSION

The Portawasher is a portable, self-contained dumpster cleaning system that is more efficient and cost-effective than the central wash system now used at many Army installations.

The Portawasher can be completely assembled from off-the-shelf items and has relatively minor operation and maintenance requirements.

An installation may be able to procure a Portawasher(s) using Army Quick Return on Investment Program funds.

## METRIC CONVERSION TABLE

1 in.	= 25.4 mm
1 ft	= 0.3048 m
1 cfm	= 1.6 m <sup>3</sup> /s
1 gal	= 3.785 L
1 lb	= 0.453 kg
1 ton	= 907 kg
1 psi	= 6.894 kN/m <sup>2</sup>
1 in. Hg	= 249 N/m <sup>2</sup>
1 hp	= 0.74 W

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